SALT CONTAMINATION OF PRIVATE WELL WATER SUPPLIES

TOWN OF WHITCHURCH — STOUFFVILLE
COMMUNITY OF BALLANTRAE

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Ministry
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MINISTRY OF THE ENVIRONMENT

TOWN OF WHITCHURCH-STOUFFVILLE
COMMUNITY OF BALLANTRAE

SALT CONTAMINATION OF PRIVATE WELL WATER SUPPLIES

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SALT CONTAMINATION OF PRIVATE WELL WATER SUPPLIES COMMUNITY OF BALLANTRAE

INTRODUCTION

In response to a request from Mr. C. Wideman, York Regional Health Unit, Newmarket, an investigation was undertaken by staff of the Central Region, Technical Support Section, to determine the cause of salty water in two wells in the Community of Ballantrae. The study area is presented in Figure I.

The study included an office examination of the hydrogeology, physiography, and water well records of the area. Water samples were collected from 19 wells over a period of 9 months. The results of the chemical analyses of these samples are reported in Table II. In October and November of 1976 a resistivity survey and a levelling survey of dug wells was conducted. Water well and sampling locations are shown in Figure 2. Interviews with concerned parties were conducted on several occasions.

The purpose of this report is to define the cause and extent of the salty water in the area and make recommendations that will help ameliorate the problem.

BACKGROUND

On March 11, 1976, Mr. Wideman requested the assistance of the staff of the Technical Support Section in interpreting the chemical analysis of a water sample collected from Mrs. A. E. Powell's well. Staff reserved comment and requested a second analysis. A second sample was collected on March 16, 1976. From the analysis it appeared that a problem with salt (i.e. sodium chloride) and nitrates was being encountered. Since staff had not visited the site and details of the well were not available, several assumptions were made and a reply forwarded to Mr. Wideman on April 15, 1976. A copy of the reply is included in Appendix A.

On June 24, 1976 Mr. Wideman stated that a neighbour, R. Huskisson, was now complaining of a similar problem and that some local residents were concerned that York Sanitation Site #4 might be responsible for the problem. He requested that Technical Support staff attempt to locate the source of the problem.

On June 28, 1976, staff visited the complainants. It was found that the Powell well although not constructed to present standards was not likely to have surface water entering the drilled portion. Water samples were then collected from 5 wells (Powell, Huskisson, Giasson, Fitzpatrick, Barkey) in what appeared to be upgradient and downgradient positions. After the results from the sampling were received, only the Powell and Huskisson wells appeared to have a problem. Therefore, on August 26, 1976, the Hope well located directly across the road from the Powell well was sampled and also showed relatively good water. It was then decided to conduct an extensive sampling of the area and a resistivity survey to determine the extent and possible cause of the problem.

On October 12, 1976, the sampling survey was conducted. On October 19, 1976, the resistivity survey was commenced. Due to adverse weather conditions, the resistivity survey was not completed until October 28, 1976. The levelling survey was conducted on November 10, 1976.

TOPOGRAPHY

The Community of Ballantrae is approximately 5.5 miles north of Stouffville and lies around the intersection of Hwy 48 and County Road 15 (the Aurora Sideroad). It lies on an essentially flat plateau with the land surface dropping gently to the south at a rate of 8.4 ft/1000 ft.. Approximately 1 mile north of Ballantrae, the land drops sharply into several stream cut valleys.

HYDROGEOLOGY

According to Gwyn and DiLabio (1) the surface deposits consist of "ice-contact stratified drift". The soils are "typified by extensive areas of medium-grained to fine-grained silty sand with occasional bodies of gravel." From well logs, this drift is approximately 60 to 65 feet deep. From approximately 60 to 90 feet a layer of clay is encountered. The existence of a clay layer was verified by the resistivity survey (E. Rodrigues, Personnel Communications). From well logs (well no. 8340) fine sand is then encountered to 170 feet. From 170 to 224 feet another clay layer is encountered which is underlain by sand and gravel. An idealized cross section is presented in Figure 6.

Surficially, drainage in the area of the intersection is to the south and south-west. This drainage

eventually joins the Holland River East Branch which flows west from the swamp area north of York Sanitation Site. On the northern side of the plateau, drainage is to the north into the various stream valleys.

From the well logs and Schoeller Plots (Figures 3-5) it appears that there are at least 3 distinct aquifers (water bearing formations) in this area. These correspond to the silty sand and sand formations. The majority of wells in the area are drilled into the upper unconfined aquifer, a fewer number of wells penetrate the middle aquifer and 2 wells located at Erie Manufacturing penetrate the lower aquifer.

Generally, in unconfined aquifers the groundwater flow direction conforms to the topographical flow direction. Thus under the influence of gravity water flows from areas of higher elevation to areas of lower elevation. In the upper aquifer then, flow should be south-west towards the Holland River East Branch.

From the levelling survey, using the dug portion of the Powell well and the abandoned well W_A as control points, the groundwater flow direction in the upper aquifer (Figure 2) is south-west; from the problem area towards the subdivision south-west of the intersection. At the time of the survey, the Giasson new well and the Stone well were being used. Thus it is felt that they do not represent equilibrium conditions. It should be noted that the gradient between the control points was very small (.0046 ft/ft). MacArthur (3) in 1972" demonstrated the local water table to be relatively flat" in the area south of the intersection.

The middle aquifer is confined by the clay layer and stratigraphically appears to be the "main aquifer" referred to by Rovers (2). From Rovers report the groundwater flow direction in this aquifer was determined to be northward in the Ballantrae area and southward in the area of the York Sanitation Site.

Since only 2 wells penetrate the lower aquifer, very little is known about the flow direction. The aquifer appears to be composed of coarser grained material and capable of high capacity production.

WATER QUALITY

A General

From the initial samples, it was obvious that the Powell and Huskisson wells contained anomalous concentrations of chloride and sodium and oxidized forms of nitrogen. The extended survey on October 12, 1976, revealed that all wells in the upper aquifer contained elevated nitrate levels and scattered wells contained elevated chloride and sodium levels. McArthur (3) in 1973 had the same findings south of the intersection. Mrs. Huskisson indicated on June 28, 1976, and Mr. Huskisson reaffirmed on October 25, 1976, that from the time they moved into the area they did not drink the water from their well. It appears that there have been problems to some degree with quality since at least 1973.

With regard to the middle aquifer, the quality is relatively good. It should be noted, however, that all wells sampled in this aquifer had an odour of hydrogen sulphide (sulphur water). It was reported at the Hope's residence that the rotten egg odour had always been present.

The lower aquifer appears to have excellent quality water.

Since the problem wells are all in the shallow aquifer, this report will concentrate mainly on this aquifer.

In dealing with aquifer contamination, several potential causes must be considered. These could include, natural quality which in some areas exceeds accepted criteria, landfilling operations, septic tank effluents, discharge of industrial waste, and road salting and salt storage.

B Potential Contaminants

(i) Chloride

Chlorides are found in all natural waters whether surface or ground. Generally the concentrations are small. However, in marine deposited environments the inclusion of connate brine can result in very high concentrations of chloride. Typically elevated concentrations of calcium, magnesium and sulphate are also found. (6, 7)

"Chloride ions in natural waters do not readily enter into oxidation or reduction reactions, do not form important ion complexes, do not form insoluble or slightly soluble salts, are not

significantly adsorbed on mineral surfaces, and do not enter into biochemical reactions. Because of these facts, chloride ions move with the water through most soils with less retardation or loss than any other chemical. However, because the ion is physically large, its movement through compacted clays and shales may be retarded" (6).

Chlorides in drinking water are generally not harmful to human beings until high concentrations are reached (4). Most limits on chloride concentrations are based on taste considerations. In Ontario, the limit of 250 ppm is considered to be the taste threshhold. The taste threshhold, however, will vary depending on the cation (calcium, sodium, magnesium) associated with the chloride ion.

Various agencies throughout the world have recommended limits ranging from 5 ppm to 600 ppm. Rudolfs maintains that even 1000 ppm is harmless (4).

In the study area, chloride concentrations in the upper aquifer varied from 10 to 1000 ppm.

(ii) Sodium

The occurrence of sodium is similar to that of chloride. Although most sodium salts are extremely soluble in water, sodium ions can be removed from solution by ion exchange. Clay soils offer the best possibilities for ion exchange. In effecting the ion exchange, however, sodium usually forces calcium into solution which in turn increases the hardness.

The sodium concentration in natural waters can range from less than 1 ppm in rainwater to more than 100,000 ppm in brines (7). The latter are usually associated with deep bedrock formations.

No limits presently exist for sodium levels in North America (5).

Sodium in drinking water may be harmful to persons suffering from cardiac, renal and circulatory diseases (4). The effects on a given individual are best assessed by the family physician.

Within the study area, sodium levels have varied from 2 to 400 ppm.

(iii) Calcium

Calcium is among the most commonly encountered substances in water. The most common forms of calcium are associated with carbonates.

Calcium may be released to solution by the process of ion exchange. If a solution with a high sodium concentration comes in contact with soils with a high cation exchange capacity and exchangeable calcium, then sodium and calcium will exchange in a 2:1 ratio and maintain charge equilibrium.

While several beneficial and adverse physiological effects of calcium in drinking water are suspected, (4, 8, 9) no definite relationship has been proven to date. Where calcium limits exist, they are based on aesthetic considerations and not based on a hazard to health.

There are no limits on calcium in Ontario at the present time.

In the study area, calcium levels varied from 18 ppm to 320 ppm.

(iv) Hardness

Hardness is not a pollutant but refers to the soap neutralizing power of water and is caused principally by the ions of calcium and magnesium.

Hardness has no detrimental effects from a physiological standpoint. The major concern with hardness is aesthetic. Hardness over 100 ppm becomes increasingly inconvenient because of the increased amounts of soap required and scale buildup in boilers, water heaters and cooking utensils.

Numerous authorities have proposed limits on hardness, varying from 140 to 500 ppm. Typically in Southern Ontario, ground waters tend to vary from 150 ppm to 300 ppm. Ontario has not established a limit for hardness.

In the study area, hardness varies from 159 to 950 ppm.

(v) Nitrate

The presence of nitrogen in the natural environment is summed up in the nitrogen cycle. Nitrogen in the form of organic nitrogen and free ammonia is introduced into the environment by plants and animals. These forms of nitrogen are then oxidized to nitrite and then nitrate, a form suitable for uptake by plants. These reactions, depending on conditions, are reversible so that denitrification can occur with the production of gaseous nitrogen compounds such as nitrous oxide and elemental nitrogen (10). The main sources of nitrates in

ground water are feed lot runoff, fertilizers, septic tank systems, sludge lagoons, rotting vegetal matter and the land application of domestic and agricultural wastes.

Nitrates in moving through soil are subject to some absorption, particularly in clay soils. The relative proportions of the various nitrogen components can also give indications as to the source of the problem and distance to the source.

High nitrate levels in water supplies have been directly linked with infant methemoglobinemia (4, 10, 11). Under the basic conditions in an infant's stomach, ingested nitrates are reduced to nitrites. The nitrites react with the hemoglobin in the blood to form methemoglobin which is unable to function as an oxygen carrier. Under acid conditions this process does not occur, thus the stricture that children under one year in age should not use this type of water. It seems likely that not all infants are susceptible to nitrate poisoning since waters containing over 500 ppm nitrate as nitrogen have never been linked with reported cases (4).

In Ontario a limit of 10 ppm of nitrate as nitrogen has been used in defining acceptable quality.

Nitrate levels in the shallow aquifer have varied from 0.1 ppm to 22 ppm nitrates as nitrogen.

(vi) Heavy Metals

Some concern was expressed over the possibility of contamination emanating from the York Sanitation Site #4. Therefore the same five heavy metals routinely analysed for at the York Site were also analyzed on the Powell and Huskisson wells. The metals all occur naturally in water to varying degrees and may be divided into two groups; those with a non-toxic effect and those with a toxic effect.

Copper, manganese and zinc have prescribed limits of 1.0, 0.05 and 5.0 ppm respectively. These limits are all based on aesthetic considerations and not on a toxic effect. All three metals are essential for nutrition and are non-cumulative in living organisms.

The copper analyses show considerable variation on the Powell well. The first sample was collected and analysed by the Ministry of Health and the second was collected by Health and analyzed by the Ministry of the Environment. It is possible that

the decimal point was misplaced on the first sample, but more likely that the sampling containers had a significant effect on the results. The first two samples were not collected in specially prepared acid washed bottles and did not have the prescribed preservative added at the time of collection.

With regard to the zinc level in the Huskisson well, it should be noted that all two inch wells in the area use galvanized (zinc coated) steel pipe for the well casing and will necessarily have higher zinc levels than other wells. The level encountered is still below the taste threshold of 5 ppm.

Chromium in the hexavalent form and lead are known to be toxic and both carry a limit of 0.05 ppm. The chromium is non-cumulative while the lead is cumulative in living organisims.

Both the chromium and the lead levels are less than the detection limit in the study area.

Under basic conditions, heavy metal ions undergo adsorption and/or precipitation very easily and thus do not migrate very far from the point of application. Generally, the heavy metal analyses lend nothing of significance to this study.

C Schoeller Plots

Because of the large amount of chemical data collected, plots as described by Schoeller (12) are used to present some of the main features, in a more easily visualized form.

The plots are constructed by first converting the parts per million of the major ions to equivalent parts per million (Table No.4). The readings are then plotted on semi-logarithmic paper and joined together to produce a broken line which represents the chemical composition of the water. Waters of similar composition produce similar patterns.

From the plots (Fig.3, 4 and 5) it can be seen that 4 distinct patterns exist. Two patterns exist in the upper aquifer with unique patterns being found in the middle and lower aquifers. In Figure 5 some time perspective is given to the data.

DISCUSSION

As a result of water quality complaints, an extensive water survey of the Ballantrae area was conducted. Well water samples were found to be affected to varying degrees by salt (sodium chloride) and nitrates.

From the hydrogeology it can be seen that 3 distinct aquifers separated by clay layers exist in this area. The upper aquifer, consisting of a silty sand, drains to the south-west and ultimately discharges in the Holland River East Branch. The flow direction was determined by the levelling survey and confirmed by the resistivity survey. The levelling survey also confirmed McArthur's finding that the water table is relatively flat and greatly affected by local pumping. The effect of pumping can be seen by comparing water levels in the two Giasson wells and the abandoned well W_A. The static level in the unused Giasson old well is lower than the abandoned well W_A which is 440 feet downgradient and results because the Giasson new well was being used at the time of the survey.

From the Schoeller plots, Figures 3 and 5, it can be seen that the Marcellus well has the lowest sodium and chloride levels and probably represents background quality. The pattern for this well does not appear to match other wells in the area. If, however, the sodium (i.e. sodium plus potassium) and chloride points are observed on the Wedley and Van Bakel wells, it will be observed that the sodium point is gradually increasing with the chloride point increasing at a greater rate. Thus the Marcellus, Wedley and Van Bakel plots show the transition from background quality to the altered quality. Plots 1, 2, 3 and 5 on Figure 3 show an increasing distortion in the sodium and chloride areas.

As explained previously, sodium will undergo ion exchange with calcium in the soil matrix and cause the calcium and hardness levels to increase. As more sodium enters the system it shows less of an increase in the water because of the ion exchange and the chloride show a greater increase because it is less susceptible to attenuation. This state of affairs will continue until all the exchangable calcium has been used up.

From the plots it can then be seen that the major problem is common salt (i.e. sodium chloride) and that increases in a number of other chemical

constituents can be explained in terms of the effects of the dissociation of sodium chloride and the ion exchange capacity of the soil.

As a source of salt, naturally occuring brine can be ruled out since brines are not associated with glacial deposits. Also the chemical composition of the water is not consistent with a connate water.

Landfilling operations although capable of producing large quantities of chloride can also be ruled out in this area. The upper aquifer at Ballantrae is distinct and separate from the "main aquifer" at the York Sanitation Site. Additionally, the groundwater flow direction in the upper aquifer is southwest or roughly towards York Sanitation.

The only industry in the area is Erie Manufacturing Company Limited; a producer of water conditioning equipment. Industrial waste is not disposed of at this site. If contamination were coming from the area of the Erie plant much higher chloride levels would be seen in the Fitzpatrick well in relation to the Powell and Huskisson wells.

All homes in the area are serviced by septic systems. Typically septic system effluents contain 80 to 120 ppm chloride. "It has been the experience of the Ministry that aquifers which have been polluted with septic tank effluents rarely have increases of chloride concentrations that exceed 10 ppm (6)." Homes employing water softeners would show considerably increased levels of sodium chloride in the septic effluent. The only residence employing a softener, however, is the Stone residence, which is 600 to 700 feet downgradient from the most affected wells. Therefore septic systems would not account for the levels of chloride being encountered.

Salt storage is not practised in this area, but both County Road 15 and Highway 48 are salted during the winter months. Typically road salt is spread at a rate of 400 pounds per mile with heavier spreading rates at intersections.

During the levelling survey, five points along the bottom of the ditch on the west side of Highway 48 were levelled (Figure 2). The survey showed that culverts in the ditch slope to the north but a high point exists in the ditch bottom which would prevent water from draining in this direction. In effect an area where salt laden water would pond in the spring has been created. This ditch was

reconstructed during 1975. The resistivity survey (See Appendix) showed the lowest resistance in the area of the ditch.

The concentration of chloride in a given well results from a number of factors. These include:

1. the depth of the well,

2. the location of the well with respect to various sources and the plume of contamination,

3. the soil conditions (i.e. lack of homogenity and zones of variable permeability),

4. the pumping of the particular well,

5. the pumping of neighbouring wells,

6. the amount of precipitation,

7. and the amount of and length of time frost is in the ground.

Whether one factor is more significant than another is beyond the scope of this report.

From an examination of the chloride levels in the Powell well it will be observed that the chloride concentration rose to a maximum in late August to early September and then started decreasing. The Huskisson well has shown a steady decrease since the initial sample in June, while the Giasson well has shown an increase.

Contaminants introduced at the ground surface would percolate downward and move with the water table. Thus from the time chloride is introduced, it would gradually rise in concentration in the ground water at a given location until a peak is reached and then start to decrease if the problem is due to an intermittent source such as road salting as opposed to a continuous source where a steady or continually increasing trend would be expected. Because of dilution the peak will also get smaller with distance from the source. This is the condition being encountered at Ballantrae.

It should also be pointed out that the spread of chloride in the aquifer is not two dimensional. Because salt water is heavier than fresh water, stratification of the water will occur. The water will have higher concentrations of chloride with depth in the aquifer and distance from the source. The chloride will then create a 3 dimensional plume of contamination.

Pumping also has an effect on the chloride levels. The more a well is pumped the more a contaminant will be drawn into the cone of pumping influence. From the resistivity survey it can be seen that the resistivity rises sharply west of the Powell and Huskinsson wells, showing that not much contaminant is getting past them. These wells are apparently acting as interceptors and are probably slowing the movement of salt in the aquifer.

Three other wells show elevated levels of chloride; these being the Stone, abandoned (W_A) and Davis wells. The Stone well is directly downgradient from Country Road 15 and as can be seen in Figure 2 has a drainage ditch constructed in front of the house which turns south and runs beside the house. It is interesting to note that the abandoned well has a lower chloride concentration than the Stone well. The difference is probably due to the difference in depth between the two wells and the fact that the abandoned well is not pumped.

The Davis well although exceeding the chloride limit by 100 ppm, is still of reasonable quality. This well is upgradient from the highway but closer to it than any other wells in the area. The chloride levels encountered are probably a consequence of pumping the well and the well's cone of influence.

All wells in the upper aquifer exhibit elevated nitrate levels. As explained previously, the nitrate level of 10 ppm nitrate as nitrogen is primarily of concern to children under one year in age. Two major sources of nitrate in the area are septic systems and agricultural practices.

The septic systems are close to the wells and probably have a significant effect. It is interesting to note, however, that the nitrate levels decrease in wells furthest from farm fields which are in production. The fields in this area are planted with corn which requires large amounts of fertilizer but only utilizes a small portion of the applied fertilizer. The American Water Work Association (13) gives average concentations of nitrogen of 18-20 ppm for domestic waste and 1-70 ppm for agricultural land (a more precise range being a function of the type of crop). Thus it appears that the agricultural setting is a more significant factor in nitrate levels.

From Figure 5 some historical perspective is given.

It will be observed that the Radford well was sampled in 1972 and the Taylor well in 1975. These plots show the same quality water as the Wedley well sampled in October 1976.

Significantly, the Radford well also shows elevated chloride, sodium, hardness and calcium levels. Thus it can be seen that there has always been some effect from salting in the area. Considering the sandy nature of the overburden this is not unexpected.

The Marcellus well shows the best quality water of the wells in the shallow aquifer. It is further from the highway and the source of contamination than any other well. In addition the level of 200 ppm of chloride in the Giasson well compared to 10 ppm in the Marcellus well may indicate that dilution in this aquifer is considerable. Thus it is reasonable to assume that if the contaminant entered the aquifer at a point further away from the populated area that the quality of water in the wells would be considerably improved because of the effects of dilution.

To briefly summarize, salt and nitrates are the contaminants in the upper aquifer in the Ballantrae area. The major source of salt in the area is road salting. The resistivity survey, the chemistry and the levelling survey all point to road salt as the source of the salt problem while the agricultural setting appears to be the major factor contributing to the nitrate levels being encountered.
Because of the hydrogeological setting and the distances involved, York Sanitation is not implicated in this problem.

RESTORATION OF SUPPLY

Several alternatives are available to restore potable supplies. These include:

i) Reverse osmosis equipment could be installed to treat the drinking and cooking water. This equipment is costly and usually produces only small quantities of water, but the quality is excellent.

ii) Wells could be drilled into the middle aquifer. The water in this aquifer is of reasonable quality but does contain hydrogen sulphide (sulphur water) and high iron. It would be imperative that any wells drilled into the middle aquifer be properly grouted through the clay layer to ensure protection of the middle aquifer.

POLICY

With regard to legal standing of the complainants in this area, two pieces of legislation are significant.

Regulation 505/72 made under The Environmental Protection Act 1971 states:

> "Where any substance used on a highway by the Crown as represented by the Ministry of Transportation and Communication or any road authority or any agent or employee of them for the purpose of keeping the highway safe for traffic under conditions of snow or ice or both is a contaminant, it is classified and is exempt from the provisions of the Act and the Regulations."

Section 31 of the Highway Improvement Act further states:

> "Notwithstanding any general or special Act, regulation, by-law or other authority, no person shall, except under a permit therefor from the Minister, place, erect or alter any building, fence, gasoline pump or other structure or any road within 150 feet of any limit of the King's Highway or within 600 feet of the centre point of an intersection;"

In the definitions of the Act, structure includes water wells.

CONCLUSIONS:

i) The nature of the overburden in this area ensures that any contaminants lost at the ground surface have the potential to contaminate wells in the upper aquifer.

ii) Salt used for road de-icing in combination with the altered surface drainage is responsible for the elevated salt levels.

iii) The elevated salt levels being encountered in wells in the Ballantrae area are not related in any way to the operation of the York Sanitation Site #4.

RECOMMENDATIONS:

i) The drainage ditch north of the Huskisson residence should be graded to the north and lined with clay, while the ditch near the Stone residence should be lined with clay. This is not a total solution to the problem since it merely transfers the contamination

to another point in the aquifer. There are, however, no wells in these areas and the distance to other wells is sufficiently great that natural dilution should bring the chloride concentration down to a tolerable level.

ii) Consideration should be given to banking and paving a strip adjacent to the curbing on both sides of the Highway. This would direct salt laden melt water into the storm drains and help reduce infiltration of salt in the built up area.

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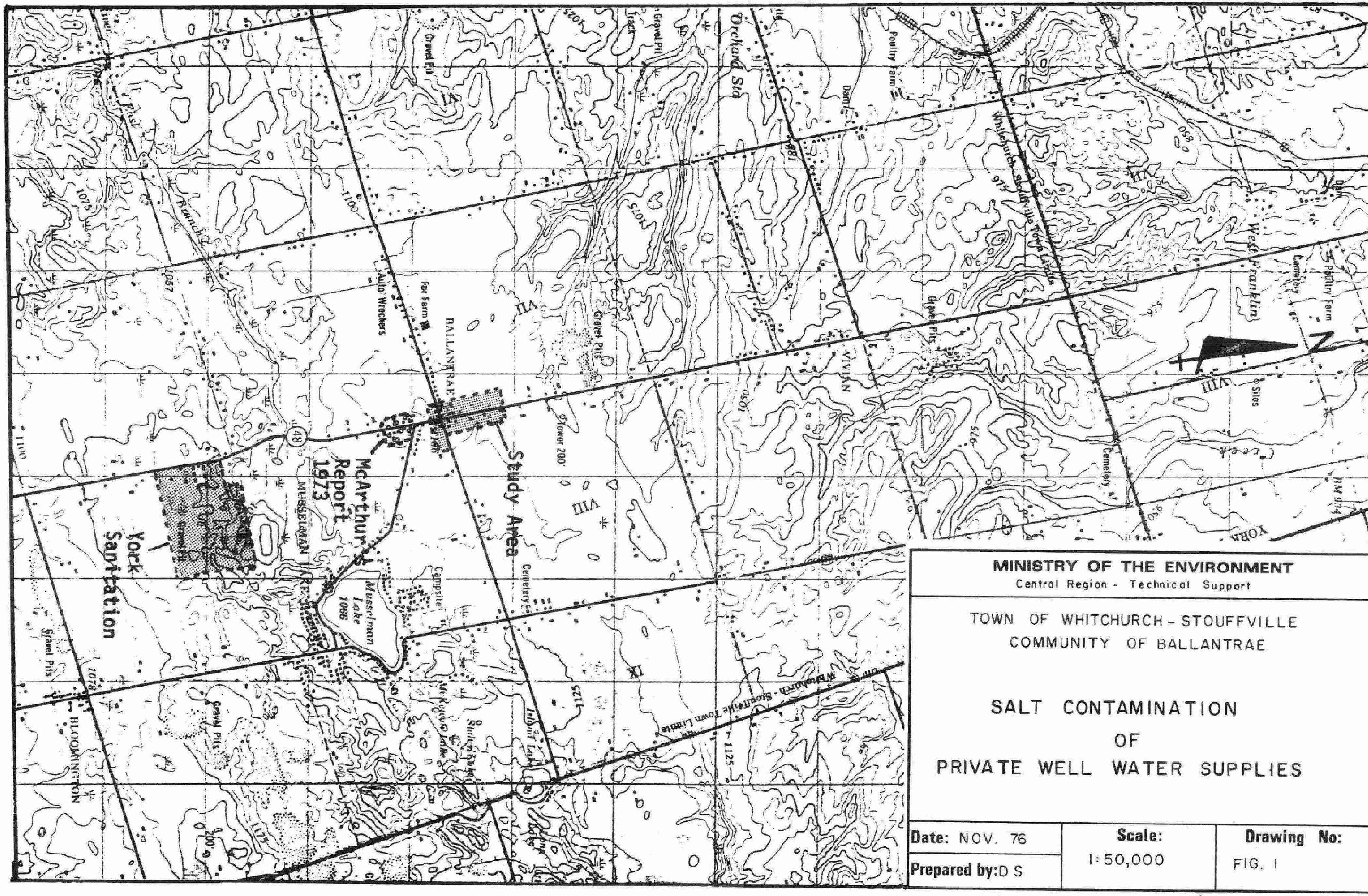
FIGURES AND TABLES



MINISTRY OF THE ENVIRONMENT

Central Region - Technical Support

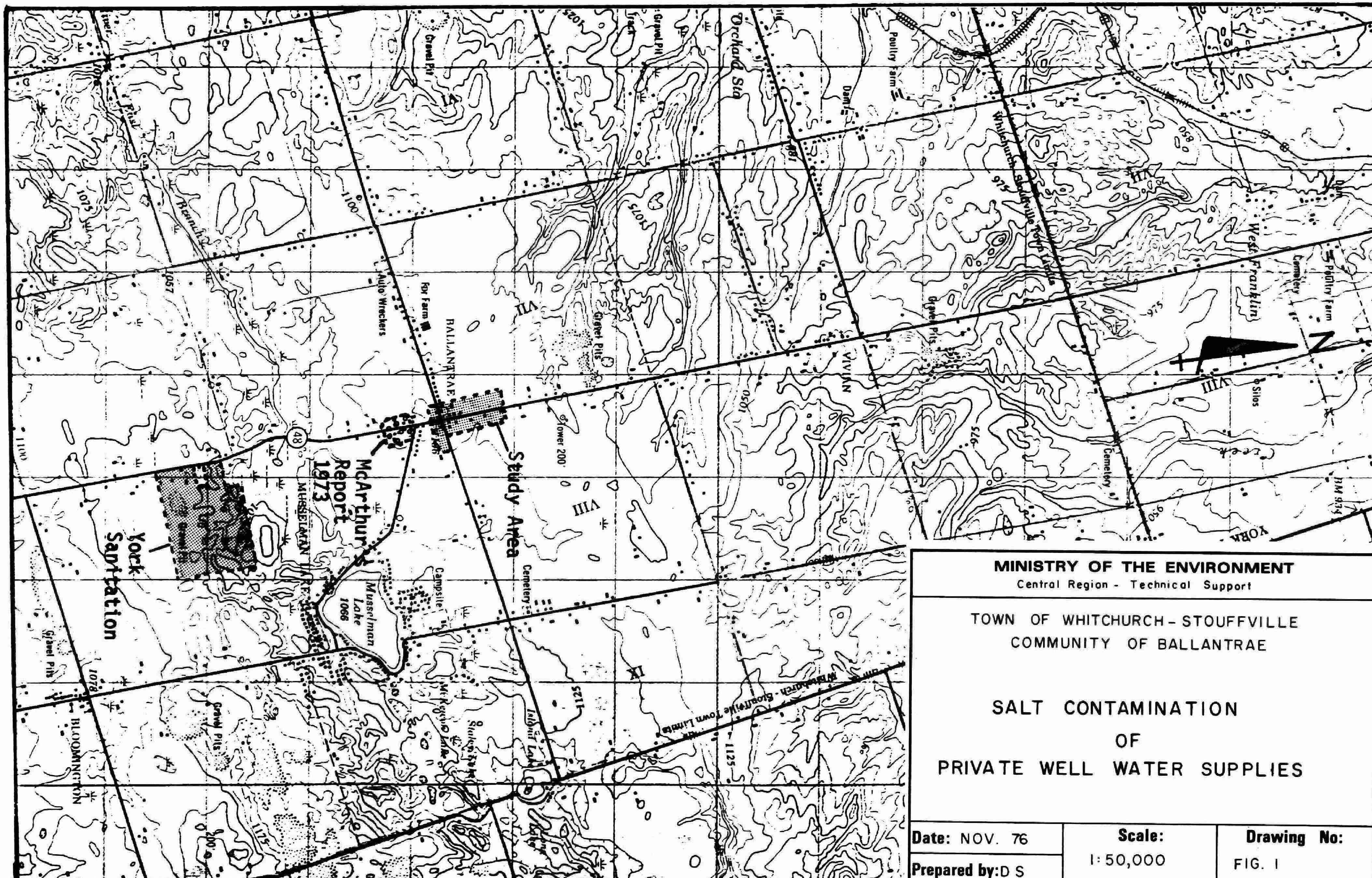
TOWN OF WHITCHURCH - STOUFFVILLE
COMMUNITY OF BALLANTRAE

SALT CONTAMINATION

OF

PRIVATE WELL WATER SUPPLIES

Date: NOV. 76	**Scale:** 1:50,000	**Drawing No:** FIG. 1
Prepared by: D S		



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SALT CONTAMINATION
OF
PRIVATE WELL WATER SUPPLIES

Date: NOV. 76	**Scale:**	**Drawing No:**
Prepared by: D S	1:50,000	FIG. 1

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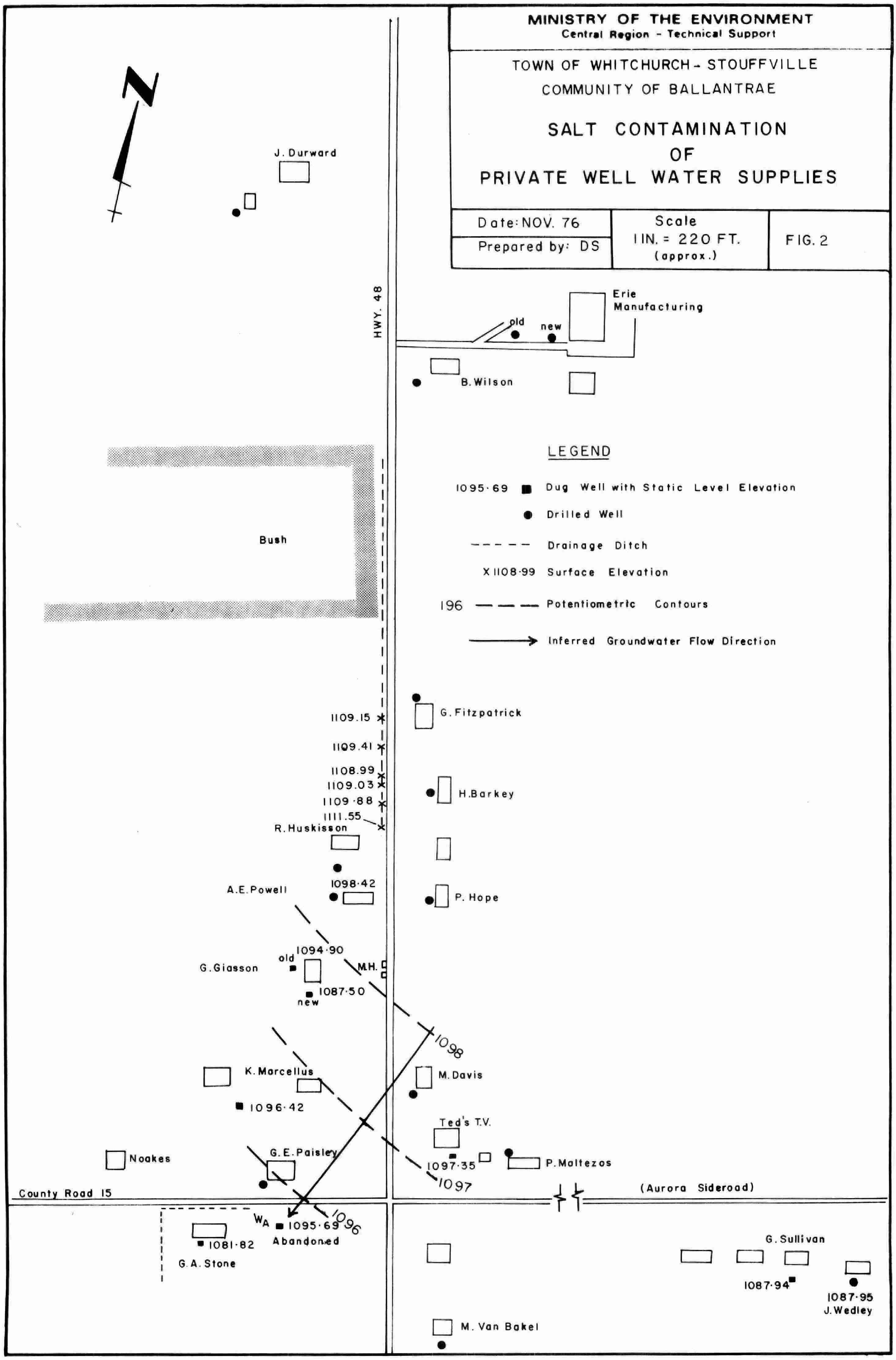
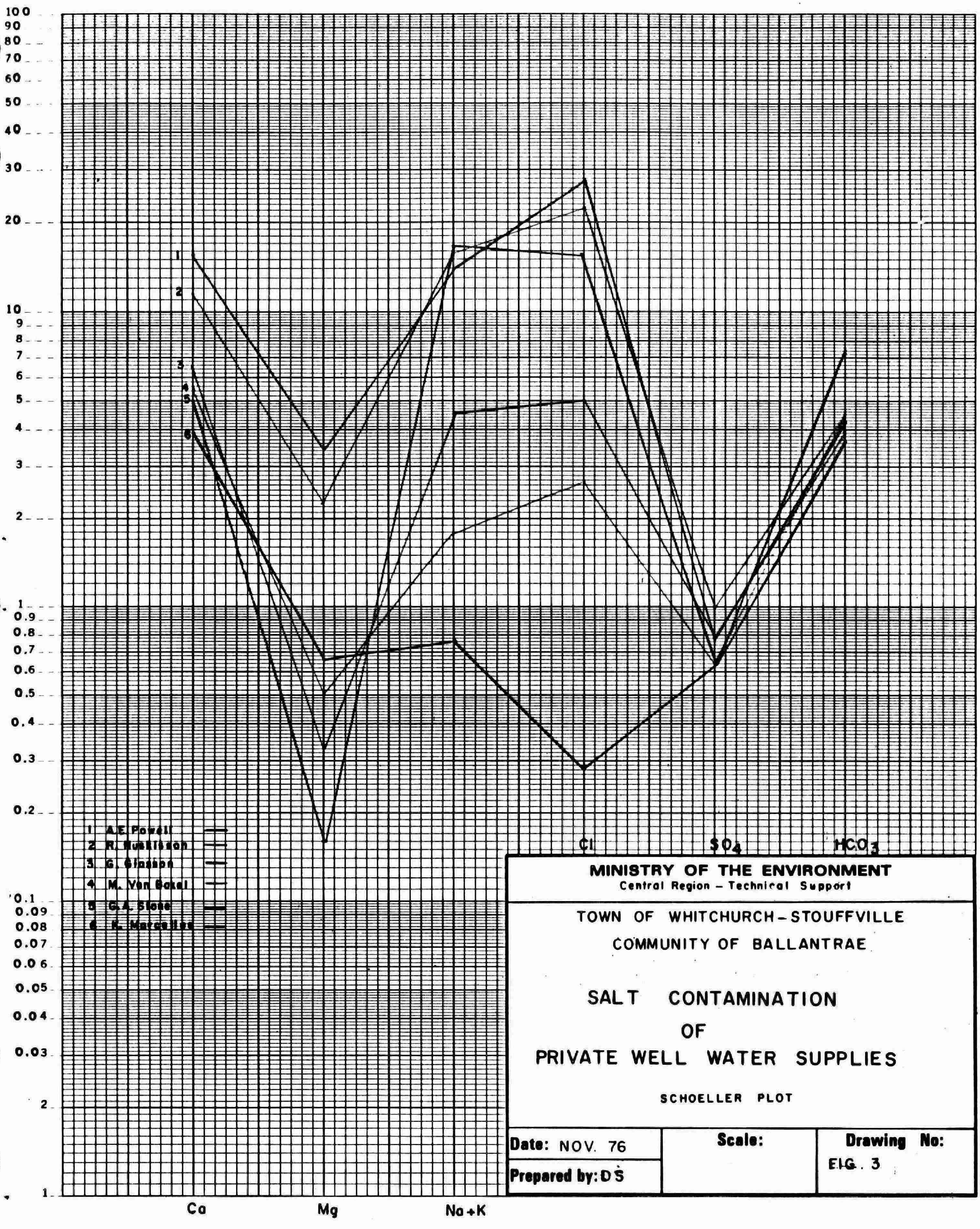
TOWN OF WHITCHURCH - STOUFFVILLE
COMMUNITY OF BALLANTRAE

SALT CONTAMINATION
OF
PRIVATE WELL WATER SUPPLIES

Date: NOV. 76	Scale 1 IN. = 220 FT. (approx.)	FIG. 2
Prepared by: DS		





MINISTRY OF THE ENVIRONMENT
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TOWN OF WHITCHURCH – STOUFFVILLE
COMMUNITY OF BALLANTRAE

SALT CONTAMINATION
OF
PRIVATE WELL WATER SUPPLIES

SCHOELLER PLOT

Date: NOV. 76	**Scale:**	**Drawing No:** FIG. 3
Prepared by: DS		

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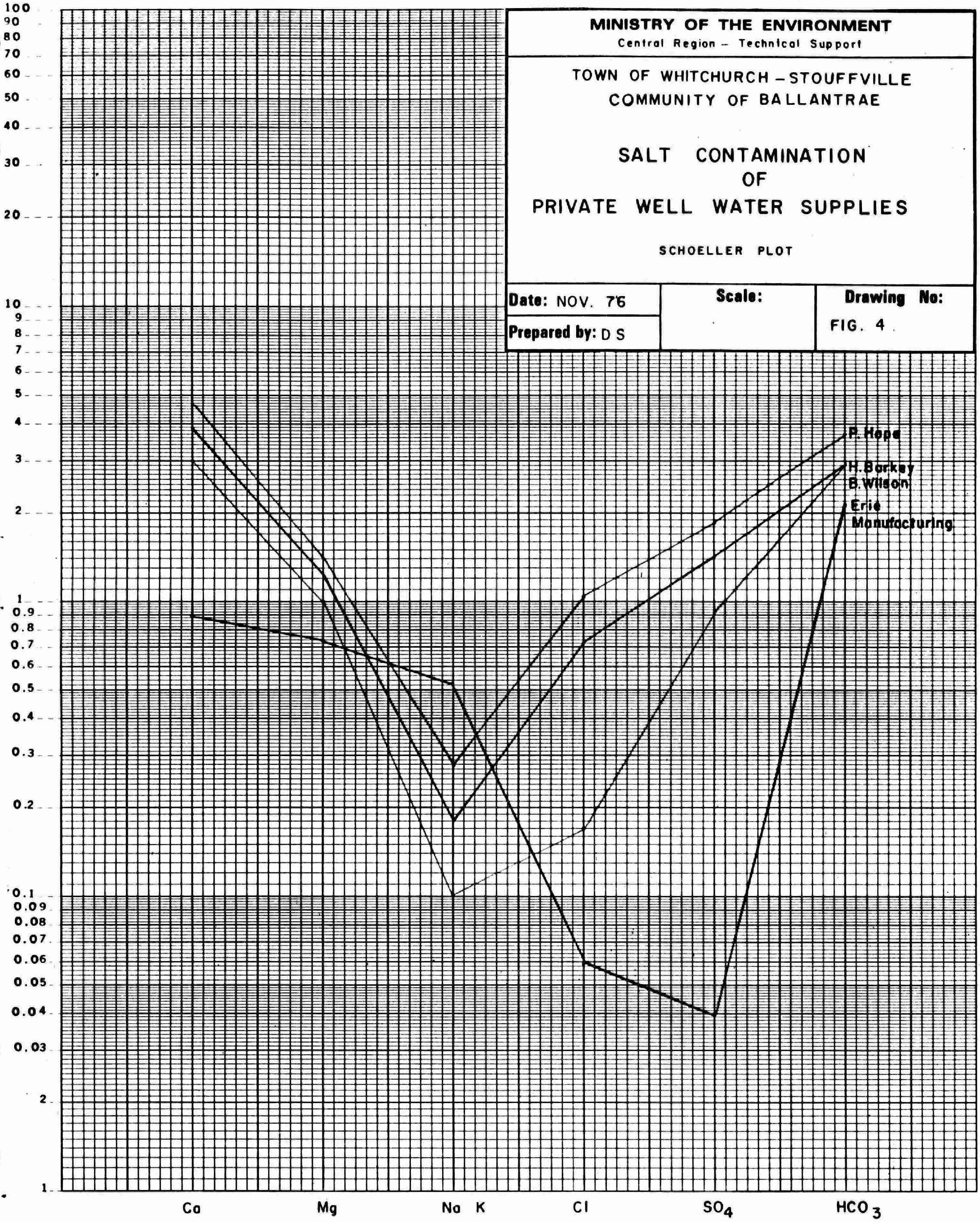
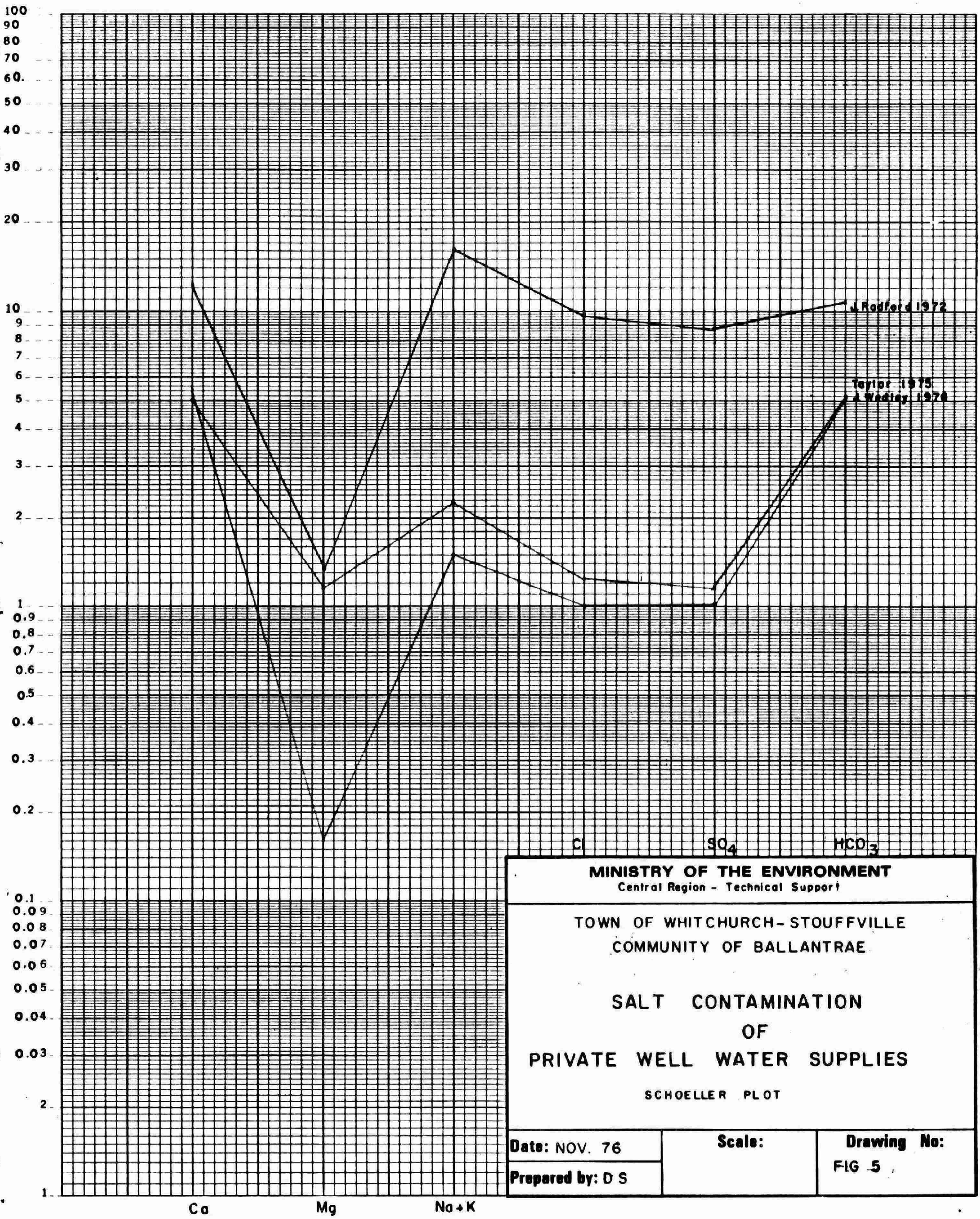
COMMUNITY OF BALLANTRAE

SALT CONTAMINATION OF PRIVATE WELL WATER SUPPLIES

SCHOELLER PLOT

Date: NOV. 76	Scale:	Drawing No:
Prepared by: D S		FIG. 4





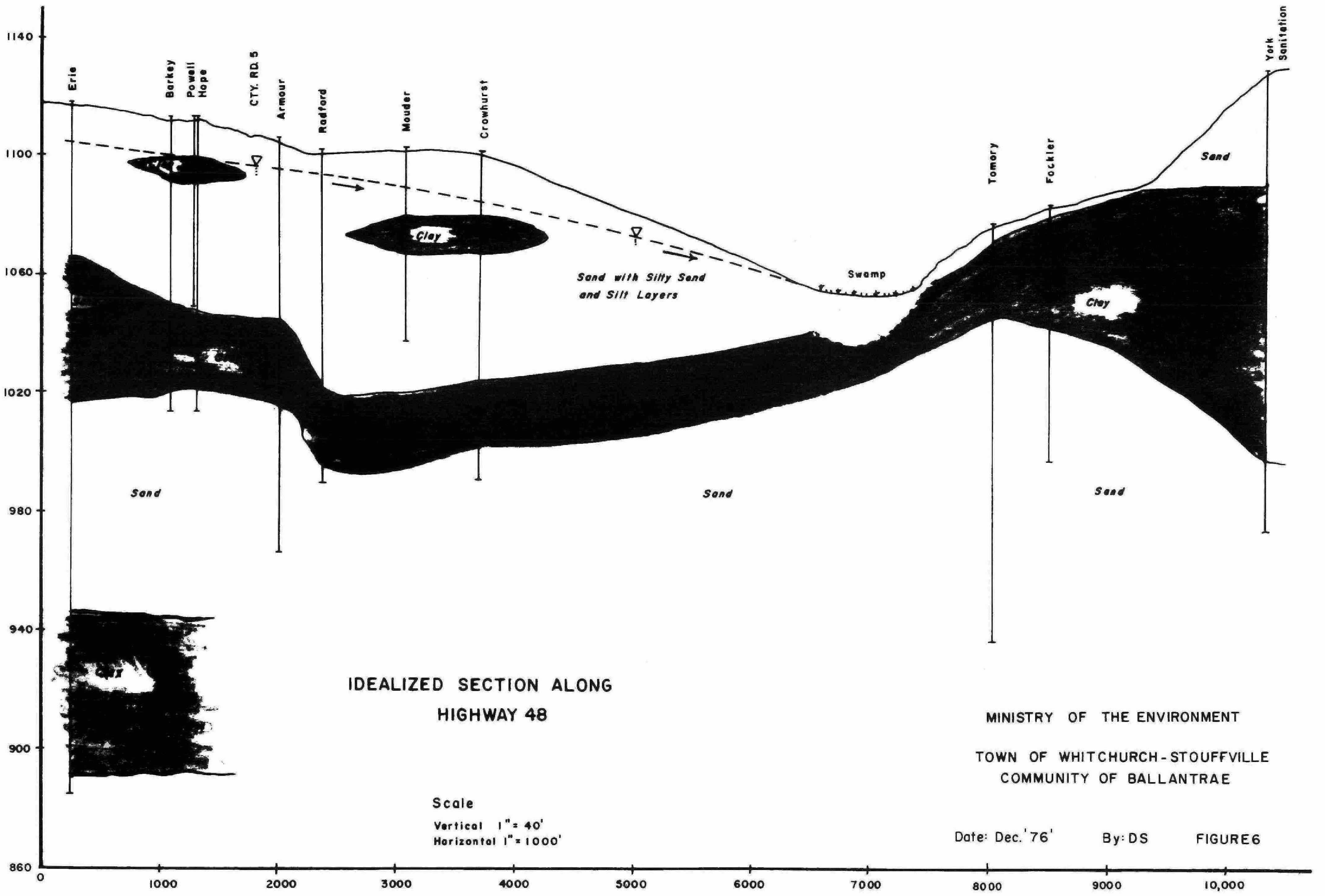
MINISTRY OF THE ENVIRONMENT
Central Region - Technical Support

TOWN OF WHITCHURCH-STOUFFVILLE
COMMUNITY OF BALLANTRAE

SALT CONTAMINATION OF PRIVATE WELL WATER SUPPLIES

SCHOELLER PLOT

Date: NOV. 76	**Scale:**	**Drawing No:** FIG 5
Prepared by: D S		


1140
1100
1060
1020
980
940
900
860
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10,000
Erie
Barkey
Powell
Hope
CTY. RD. 5
Armour
Radford
Mouder
Crowhurst
Tomory
Fockler
York
Sanitation
Clay
Sand with Silty Sand
and Silt Layers
Swamp
Sand
Clay
Sand
Sand
Sand
IDEALIZED SECTION ALONG
HIGHWAY 48
MINISTRY OF THE ENVIRONMENT
TOWN OF WHITCHURCH-STOUFFVILLE
COMMUNITY OF BALLANTRAE
Scale
Vertical 1" = 40'
Horizontal 1" = 1000'
Date: Dec. '76'
By: DS
FIGURE 6

MINISTRY OF THE ENVIRONMENT

Table I

Prepared by: D.S.

Well Owner and Number	Type	Measuring Point Elevation	Depth (ft)	Static Level	Bottom Elevation	Static Level Elevation	Dia. (in)	Remarks and Logs
A.E. Powell	Drill	1111.92	65 R	-			5	Drilled through bottom of dug well.
A.E. Powell	Dug	1111.92	14.1 M	13.50 M	1097.82	1098.42	36	Bottom full of tree roots. Not in use.
R. Huskisson	Drill	-	60 R	-			2	
G. Giasson New Well	Dug	1112.16	35.00 M	24.66 M	1077.16	1087.50	36	
G. Giasson Old Well	Dug	1111.40	22.50 M	16.50 M	1088.90	1094.90	36	No in use.
Abandoned	Dug	1104.94	14.25 M	9.25 M	1090.69	1095.69	36	Not in use
H. Barkey 10900	Drill	-	97 L	40 L			6	0-12 Sa; 12-22 Cl; 22-33 Sa,Cl; 33-62 Si; 62-81 Cl,Si; 81-89 Si; 89-90 Cl; 90-97 Sa

NOTES: M-value measured by MOE staff in field
L-value reported on well log
R-reported by resident, no log available, well inaccessible for measurement

SYMBOLS
Sa - Sand
Cl - Clay
Si - Silt
Gr - Gravel

MINISTRY OF THE ENVIRONMENT

Table I

Prepared by: D.S.

Well Owner and Number	Type	Measuring Point Elevation	Depth (ft)	Static Level	Bottom Elevation	Static Level Elevation	Dia. (in)	Remarks and Logs
M. Davis 8336	Drill	1109.72	36 L	14 L	1073.72	1095.72	2	0-12 Dug Well 12-32 Sa, Cl 32-36 Sa
J. Durward?	Drill	-	80 L	-			2	Possibly well log 9946.
Erie Manufacturing 11090	Drill	-	241 L	70 L			6	0-8 Sa 8-18 Gr,Cl 18-50 Sa 50-62 Cl 62-87 Sa 87-100 Cl 100-170 Sa 170-224 Cl 224-241 Sa,Gr
G. Fitzpatrick	Drill	-	45 R	-			6	in well pit and sealed.
P. Hope 10886	Drill	-	97 L	40 L			6	0-9 Sa 9-24 Cl 24-33 Sa,Cl 33-64 Si 64-81 Cl,Si 81-85 Si 85-89 Cl 89-97 Sa
K. Marcellus	Dug	1111.27	19.10 M	14.85 M	1092.17	1096.42	36	
G.E. Paisley	Drill	-	-	-			2	In well pit with hand pump
G.A. Stone	Dug	1102.62	26.55 M	20.80 M	1076.07	1081.82	36	

MINISTRY OF THE ENVIRONMENT

Table I

Prepared by: D.S.

Well Owner and Number	Type	Measuring Point Elevation	Depth (ft)	Static Level	Bottom Elevation	Static Level Elevation	Dia. (in)	Remarks and Logs
G. Sullivan	Dug	1105.19	27.95 M	17.25 M	1077.24	1087.94	36	
Ted's T.V.	Dug	1110.60	16.45 M	13.25 M	1094.15	1097.35	36	
M. Van Bakel	Drill	-	33 R	-			2	No seal
J. Wedley 8321	Drill	1106.05	57 L	18.10 M	1049.05	1087.95	5	0-25 Dug Well 25-47 Cl, Si 47-57 Sa
J. Wedley	Dug	1106.05	23.05 M	18.10 M	1083.00	1087.95	36	Drilled through bottom of dug well. Does not appear to be seal on drilled well.
B. Wilson	Drill	-	90 R	-			6	

MINISTRY OF THE ENVIRONMENT

Table II Summary of Water Analyses

Prepared by: D.S.

Source and Number	Location	Date Sampled	pH	BOD	Total Hardness as $CaCO_3$ (ppm)	Alkalinity as $CaCO_3$ (ppm)	Specific Conductance mmhos at 25°C	Chemical Constituents in parts per million (ppm)														
								Chloride (Cl)	Sulphate (SO_4)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Nitrogen as N				Phosphorus as P			
															Free Ammonia	Total Kjeldahl	Nitrite	Nitrate	Tot.	Sol.		
A.E. Powell* Drilled	Kitchen Tap by MOH	March 1976	7.9		800	200		800	8	0.24	268	32	299					7.5				
	Kitchen Tap	March 16/76	7.4		930	210	3540	872	55	0.4	328	27	300	2.1	<.1	0.1	<.01	7.0				
	Kitchen Tap	June 28/76	7.4		960	212	3200	986	37	.25	316	42	320	2.1	<.1	<.1	<.01	8.9				
	Kitchen Tap	Aug. 26/76	7.4		950	214	3100	1003	39	.7	320	37	330	1.8	<.1	0.2	<.01	8.8				
	Kitchen Tap	Nov. 8/76	7.5		918	224	3050	979	41	0.28	304	38	320	1.7				9.4				
A.E. Powell Dug Well	Sampler	Sept. 30/76	7.3		376	285	920	132	49	2.8	133	11	63	3.3	<.1	0.4	<.01	<.1				
R. Huskisson	Kitchen Tap	June 28/76	7.6		690	226	2800	783	48	0.2	232	27	360	2.8	<.1	<.1	<.01	14				
	Kitchen Tap	Oct. 12/76	7.5		642	235	2500	732	44	0.3	216	25	310	2.5	<.1	0.2	.02	11				
	Kitchen Tap	Nov. 8/76	7.6		649	246	2500	724	48	0.21	224	22	310	2.0				10				

*NOTE: This sample collected and analysed by Ministry of Health.
All other analyses performed by Ministry of the Environment.

MINISTRY OF THE ENVIRONMENT

Table II Summary of Water Analyses

Prepared by: D.S.

Source and Number	Location	Date Sampled	pH	BOD	Total Hardness as $CaCO_3$ (ppm)	Alkalinity as $CaCO_3$ (ppm)	Specific Conductance mmhos at 25°C	Chemical Constituents in parts per million (ppm): Chloride (Cl)	Sulphate (SO_4)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Nitrogen as N: Free Ammonia	Total Kjeldahl	Nitrite	Nitrate	Phosphorus as P: Tot.	Sol.		
G. Giasson	Kitchen Tap New Well	June 28/76	7.5		340	197	1115	176	38	<.05	130	4	99	8.3	<.1	0.2	<.01	22				
	Sampler New Well	Oct. 12/76	7.8		372	223	1170	205	45	<.05	131	11	110	8.6	<.1	0.3	<.01	18				
G. Giasson	Sampler Old Well	Oct. 12/76	7.8		337	243	870	134	40	0.7	123	7	64	4.8	<.1	0.3	<.01	0.4				
Abandoned	Sampler	Oct. 12/76	7.9		159	281	1390	302	21	1.2	60	2	250	3.8	0.3	0.7	.02	<.1				
H. Barkey 10900	Outside Tap	June 28/76	7.8		252	146	470	26	69	0.7	77	15	4	0.5	<.1	0.1	<.01	<.1				
M. Davis 8336	Kitchen Tap	Oct. 22/76	7.3		532	176	1480	356	37	0.2	166	28	115	1.4	0.1	0.1	<.01	17				
J. Durward	Kitchen Tap	Oct. 12/76	7.5		404	209	870	155	36	0.2	118	26	34	0.9	<.1	0.1	.01	1.6				
Erie Manufac. 11090	Office Tap	Oct. 12/76	8.2		82	106	195	2	2	0.1	18	9	12	0.5	0.3	0.4	<.01	<.1				
G. Fitzpatrick	Kitchen Tap	June 28/76	7.8		234	145	460	24	17	0.5	78	10	5	0.5	<.1	<.1	<.01	13				

MINISTRY OF THE ENVIRONMENT

Table II Summary of Water Analyses

Prepared by: D.S.

Source and Number	Location	Date Sampled	pH	BOD	Total Hardness as $CaCO_3$ (ppm)	Alkalinity as $CaCO_3$ (ppm)	Specific Conductance mmhos at 25°C	Chemical Constituents in parts per million (ppm)												
								Chloride (Cl)	Sulphate (SO_4)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potasium (K)	Nitrogen as N				Phosphorus as P	
															Free Ammonia	Total Kjeldahl	Nitrite	Nitrate	Tot.	Sol.
P. Hope 10886	Kitchen Tap	Aug. 26/76	7.6		302	184	540	37	89	0.95	94	17	6	0.7	< .1	0.1	<.01	0.1		
K. Marcellus	Kitchen Tap	Oct. 12/76	7.6		230	187	480	10	31	<.05	78	8	7	18	< .1	0.4	<.01	10		
G.E. Paisley	Hand Pump	Oct. 12/76	7.6		203	197	435	13	14	0.05	70	7	14	11	< .1	0.2	<.01	5.2		
G.A. Stone	Sampler	Oct. 12/76	8.0		254	375	2150	547	31	0.05	99	2	400	2.7	< .1	0.2	<.01	0.8		
G. Sullivan	Kitchen Tap	Oct. 12/76	7.7		291	175	690	75	38	<.05	106	7	39	1.3	< .1	0.1	<.01	15		
Ted's T.V.	Sampler	Oct. 12/76	7.6		198	173	400	18	13	0.40	74	3	8	2.3	< .1	0.3	<.01	4.3		
M. Van Bakel	Outside Tap	Oct. 12/76	7.5		298	221	700	95	31	0.05	109	6	39	2.9	< .1	0.2	<.01	2.4		
J. Wedley 8321	Sampler Dug Portion	Oct. 12/76	7.3		284	255	650	35	49	0.1	110	2	34	1.1	< .1	0.3	<.01	4.3		
	Kitchen Tap Drilled	Oct. 22/76	7.2		297	253	660	34	41	0.02	109	6	36	1.5	< .1	0.3	<.01	4.4		
B. Wilson	Barn Tap	Oct.	7.8		199	150	360	6	45	1.0	60	12	2	0.5	< .1	0.1	<.01	< .1		

MINISTRY OF THE ENVIRONMENT

Table III

Prepared by: DS

ANALYSIS OF HEAVY METALS

Source	Date Sampled	Cu	Zn	Pb	Cr	Mn	Remarks
A.E.Powell	March 1976	1.3					Collected and analysed by Ministry of Health
	March 16/76	0.16					Collected by MOH Analysed by MOE
	Sept. 30/76	0.04	<0.01	<0.01	<0.01	<0.01	Collected and analysed by MOE
R.Huskisson	Oct. 12/76	0.02	2.6	<0.01	<0.01	<0.01	

NOTES: Cu Copper

Zn Zinc

Pb Lead

Cr Chromium

Mn Manganese

All constituents listed in parts per million

Table IV

MINISTRY OF THE ENVIRONMENT

Prepared by:

CHEMICAL BALANCE OF IONIC EQUIVALENTS

CATIONS

Ion	Ca			Mg			Na			K			Na+K	Total
Conversion Factor	ppm .0499			ppm .0822			ppm .0435			ppm .0256				
Well	ppm	epm	%	ppm	epm	%	ppm	epm	%	ppm	epm	%		epm
POWELL	316	15.8	47.6	42	3.45	10.4	320	13.9	41.9	2.1	.05	.1	14.0	33.2
HUSKISSON	232	11.6	39.3	27	2.22	7.5	360	15.7	53.2	2.8	.07	.2	15.7	29.5
GIASSON NEW WELL	130	6.49	57.2	4	0.33	2.9	99	4.31	38.0	8.3	.21	1.9	4.52	11.34
VAN BAKEL	109	5.44	70.6	6	0.49	6.3	39	1.70	22.0	2.9	.07	0.9	1.77	7.7
STONE	99	4.94	21.9	2	0.16	0.7	400	17.4	77.0	2.7	.07	0.3	17.5	22.6
MARCELLUS	78	3.89	73.4	8	0.66	12.5	7	0.3	5.7	18	.46	8.6	.76	5.3
HOPE	94	4.69	73.6	17	1.4	22	6	0.26	4.0	0.7	.02	.3	.28	6.37
BARKEY	77	3.84	73.1	15	1.23	23.4	4	0.17	3.2	0.5	.01	.2	.18	5.25

ANIONS

Ion	Alk as $CaCO_3$			SO_4			Cl			Total	Diff %
Conversion Factor	ppm .0200			ppm .0208			ppm .0282				
Well	ppm	epm	%	ppm	epm	%	ppm	epm	%	epm	
POWELL	212	4.2	12.8	37	.77	2.3	986	27.8	84.8	32.8	1.2
HUSKISSON	226	4.52	16.4	48	.99	3.6	783	22.1	80	27.6	6.8
GIASSON NEW WELL	197	3.94	40.7	38	.79	8.2	176	4.96	51.1	9.69	17
VAN BAKEL	221	4.42	57.1	31	.64	8.3	95	2.68	34.6	7.74	.5
STONE	375	7.5	31.8	31	.64	2.7	547	15.43	65.5	23.57	4.1
MARCELLUS	187	3.74	80.3	31	.64	13.7	10	.28	6.0	4.66	13.7
HOPE	184	3.68	56.0	89	1.85	28.2	37	1.04	15.8	6.57	3.0
BARKEY	146	2.9	57.2	69	1.44	28.4	26	0.73	14.4	5.07	3.5

MINISTRY OF THE ENVIRONMENT

Table IV

Prepared by:

CHEMICAL BALANCE OF IONIC EQUIVALENTS

CATIONS

Ion	Ca			Mg			Na			K			Na+K	Total
Conversion Factor	ppm .0499			ppm .0822			ppm .0435			ppm .0256				
Well	ppm	epm	%	ppm	epm	%	ppm	epm	%	ppm	epm	%		epm
WILSON	60	2.99	73.3	12	0.99	24.3	2	.09	2.2	0.5	.01	.2	0.1	4.08
ERIE MANUFACTURING	18	.90	41.5	9	0.74	34.1	12	.52	24.0	0.5	.01	.5	.53	2.17
WEDLEY	110	5.49	76.7	2	0.16	2.2	34	1.48	20.7	1.1	.03	.42	1.51	7.16
TAYLOR	100	4.99	59.5	14	1.15	13.7	48	2.09	24.9	6.1	.16	1.9	2.25	8.39
RADFORD	243	12.1	41.3	16	1.32	4.5	355	15.4	52.6	20	.51	1.7	15.9	29.3

ANIONS

Ion	Alk as $CaCO_3$			SO_4			Cl			Total	Diff. %
Conversion Factor	ppm .0200			ppm .0208			ppm .0282				
Well	ppm	epm	%	ppm	epm	%	ppm	epm	%	epm	
WILSON	150	3.0	73	45	.94	22.9	6	.17	4.1	4.11	.73
ERIE MANUFACTURING	106	2.12	95.5	2	.04	1.8	2	.06	2.7	2.22	2.2
WEDLEY	255	5.1	71.7	49	1.02	14.3	35	.99	13.9	7.11	.7
TAYLOR	259	5.18	68.6	56	1.16	15.4	43	1.21	16.0	7.55	11.1
RADFORD	547	10.94	37.2	*424	8.82	30.0	342	9.64	32.8	29.4	-
NOTE: *Calculated Value											

APPENDIX A

April 15, 1976.

York Regional Health Unit,
22 Prospect Street,
Newmarket, Ontario.

Attention: Mr. C.E. Wideman

Dear Sir:

Re: Whitchurch-Stouffville - A.E. Powell

This letter serves to confirm our verbal comments of April 2, 1976.

From a review of available data on the Ballantrae area, it appears that there are 2 aquifers in this area; one a shallow watertable aquifer, the other a deep artesian aquifer. With respect to the shallow aquifer, Ballantrae is sitting on a groundwater divide. The potentiometric surface is therefore relatively flat and greatly influenced by local pumping. This aquifer is also subject to degredation from contaminants lost at the ground surface. The artesian aquifer is not as greatly influenced by local pumping of private wells and should have superior quality water since it is less likely to be affected by contaminants lost at the ground surface.

From looking at the low potasium, magnesium and sulphate levels, it is concluded that the problem is not due to connate water. Rather, it is felt that the problem is arising from surface runoff gaining entrance to the dug portion of the well. The elevated hardness, calcium and total solids are also a result of salt laden water entering from the surface. Numerous shallow wells in Ballantrae have shown elevated sodium and chloride levels in the past; these levels probably resulting from the road salting required for Hwy. 48 and County Road 15.

The high nitrate levels would also seem to indicate that surface runoff is entering the well. However, since the free ammonia and total Kjeldahl are approximately equal, the nitrate appears to be coming from an inorganic source, suggesting perhaps the use of inorganic nitrate fertilizers in the area.

With respect to the chloride level, 872 ppm, this level greatly exceeds this Ministry's recommended limit of 250 ppm. The physiological effect of this level though is hard to assess, since various authors and authorities have indicated that levels varying from 400 to 1000 ppm can be tolerated. Excessive chloride levels can, however, cause temporary diarrhea in people not accustomed to these levels. Although no criteria exists for sodium levels, the usual caution regarding the use of this water by people on sodium restricted diets should be observed. The Powell's family doctor may be better able to assess these factors.

It is felt that better quality water would be obtained by sealing the drilled portion of the well and using water only from the drilled portion. If the well is properly screened it may be possible to use the 2 inch casing directly as the intake. Alternatively sanitary seals are now available for 2 inch drilled wells. They are available from :

Wheeling Industries Limited,
220 Ramsey Drive,
Dunnville, Ontario.

With respect to the copper levels encountered, it would appear that the decimal point was misplaced on the initial report, since a level of 1.3 ppm of copper would be highly unusual.

I trust that these comments are satisfactory.

Yours very truly,

D. Smith

D. Smith, C.E.T.,
Hydrogeology Technician,
Technical Support Section.

DS:ce
3-5,9

cc: Mr. W. Lammers
Mr. A. Mellary

Ontario

Ministry of the Environment

135 St. Clair Avenue West
Suite 100
Toronto Ontario
M4V 1P5

Tel: 965-2105

December 21, 1976

MEMORANDUM

TO: D. Smith
Technical Support Section
Central Region

FROM: E. Rodriques
Hydrology and Monitoring Section
Water Resources Branch

RE: RESISTIVITY SURVEY COMMUNITY OF BALLANTRAE

At your request a resistivity survey was carried out in the Community of Ballantrae to determine whether road salting operations along Highway 48 had resulted in a deterioration of water quality in three wells at Ballantrae.

The chloride concentration of 1000 ppm and conductivity of 3,000 micro-mhos/cm in one of the wells was considered high enough to enable the zone of the contamination to be mapped by the resistivity technique. Twelve vertical electrical soundings (VES) were carried out using the Wenner electrode configuration. Figure 1 shows the general layout of the area and the location of the soundings. The contaminated wells are those of Messrs. Muskisson, Powell and Giasson. The results of the soundings are shown in Figure 2 and are plotted in three groups for comparison. Groups 1 and 2 show the sections across the highway and group 3 shows the section parallel to it.

The Muskisson and Powell wells are reported to be drilled to a depth of 60 feet each and that of Giasson is constructed to a depth of 30 feet. The static level in the wells is about 10 feet. No well logs are available. However, the log for a well drilled to a depth of 36 feet opposite the Marcellus property on the east side of Highway 48 shows that the overburden consists of sand with clay to a depth of 32 feet and fine sand from 32-36 feet.

The soundings adjacent to Highway 48 (VES 1, 2, 3, 4 & 6) all show low values of resistivity ranging from 70-150 ohm/feet for the formation below the water table. In all the other soundings the resistivity of this formation is higher. It may be noted that the very low values of 70 ohm/ft and 90 ohm/feet in VES 1 and 2 occur near the property of Mr. Muskisson whose well has been severely contaminated.

In conclusion, it may be stated that the low values of resistivity occur only in the immediate vicinity of the highway. It is likely that these low values are due to a deterioration of ground water quality as a result of road salting operations along Highway 48 at Ballantrae. The contaminated wells are located near the highway and obtain water from the portion of the aquifer contaminated with road salt.

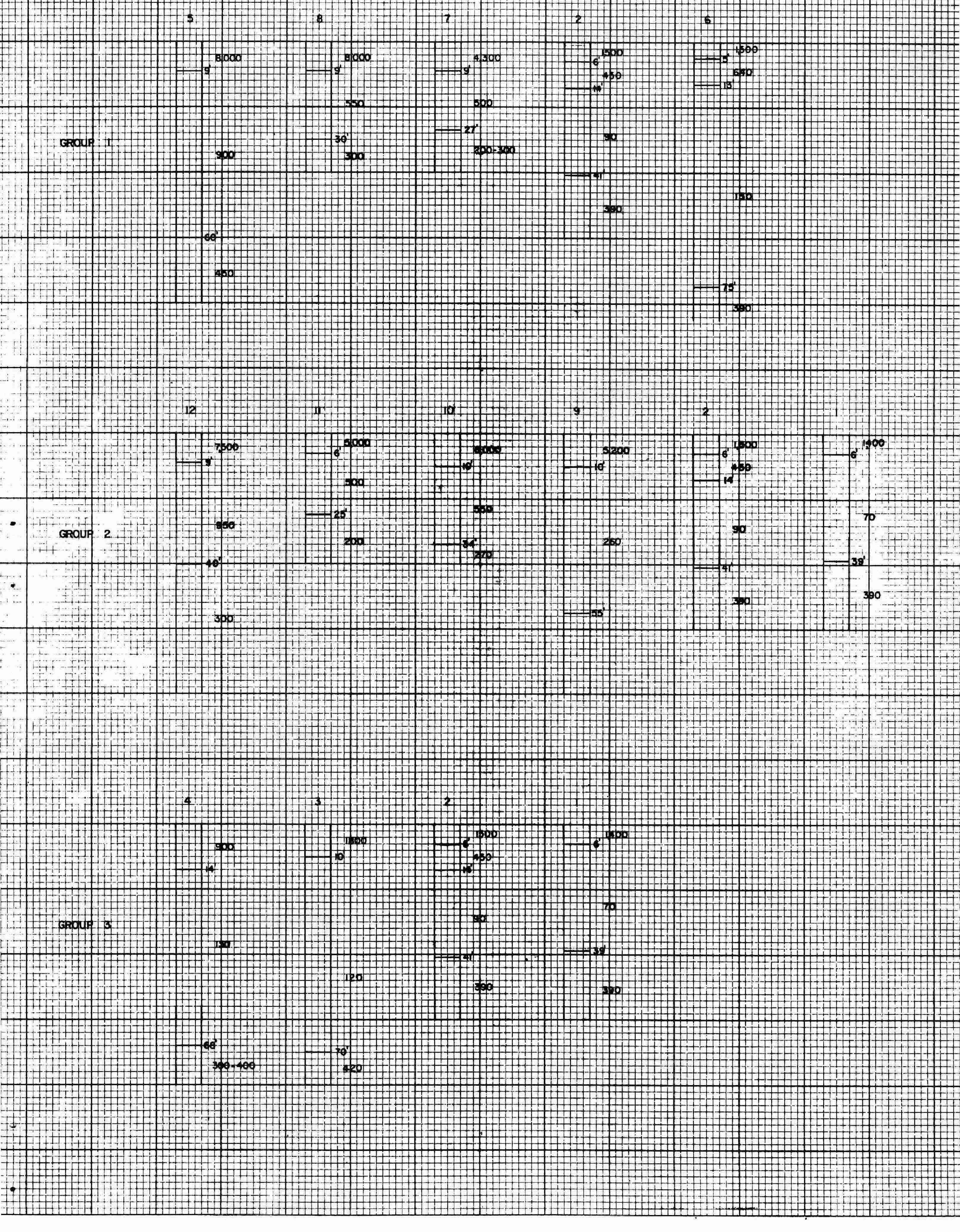
E. Rodrigues

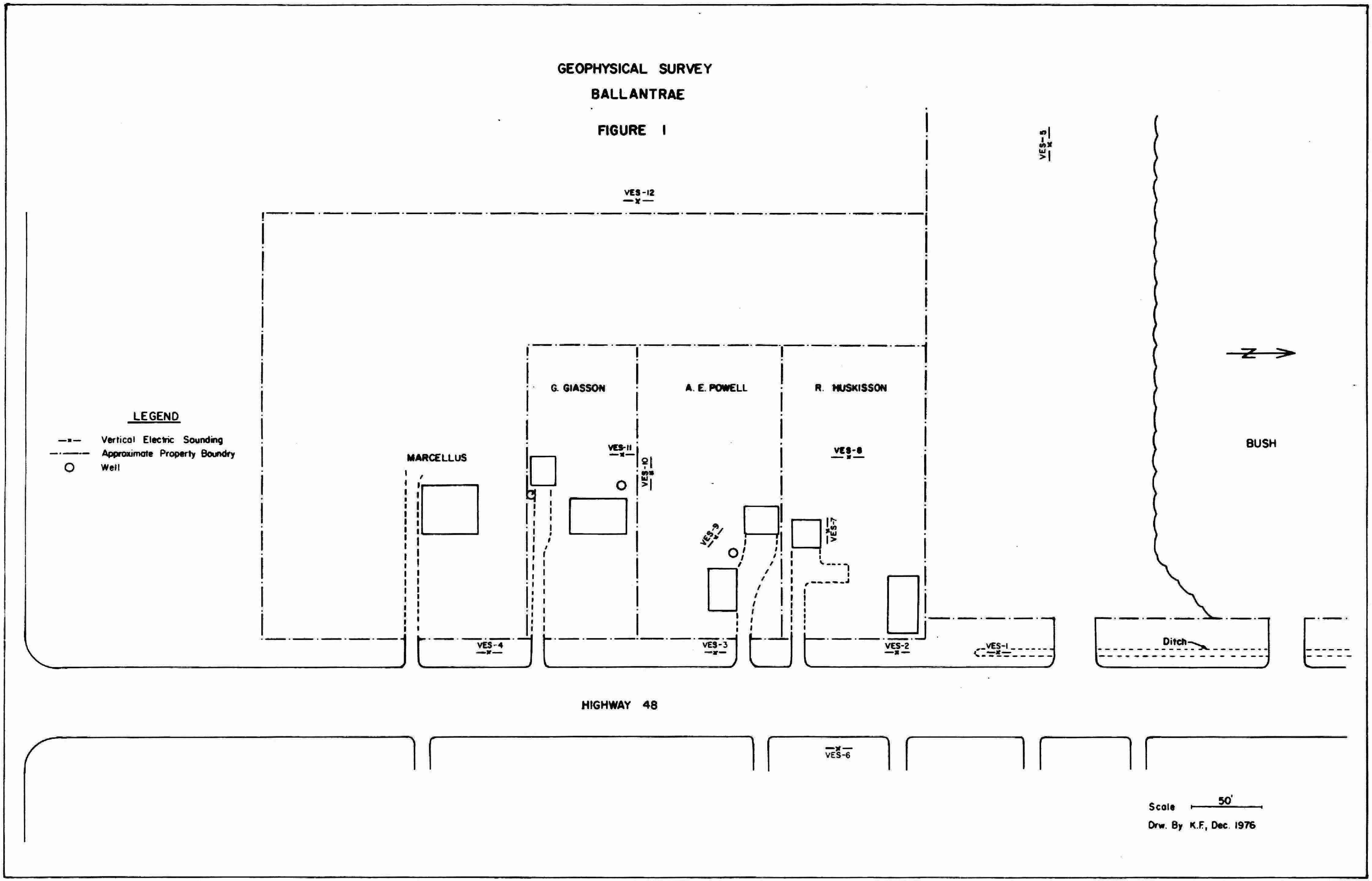
ER/sh

RESULTS OF VERTICAL ELECTRIC SOUNDINGS

BALLANTRAE

FIGURE 2





GEOPHYSICAL SURVEY
BALLANTRAE
FIGURE I
LEGEND
Vertical Electric Sounding
Approximate Property Boundry
Well
VES-12
VES-5
G. GIASSON
A. E. POWELL
R. HUSKISSON
MARCELLUS
VES-11
VES-10
VES-8
VES-9
VES-7
BUSH
VES-4
VES-3
VES-2
VES-1
Ditch
HIGHWAY 48
VES-6
Scale
50'
Drw. By K.F., Dec. 1976